WHAT IS CLAIMED IS:

1. A laser, comprising:

a traveling wave ring laser resonator;

first, second, and third optically nonlinear crystals located in said ring resonator;

said ring resonator including at least one gain-element generating fundamental radiation in said ring resonator, said fundamental radiation circulating through said first second and third optically nonlinear crystals in the sequence listed;

said first optically nonlinear crystal arranged to convert a portion of said fundamental radiation to second-harmonic radiation;

said second optically nonlinear crystal arranged to convert a portion of said second-harmonic radiation from said first optically nonlinear crystal into radiation having a converted frequency different from the frequency of said second-harmonic radiation; and

wherein said third optically nonlinear crystal is arranged to convert at least a portion of a remaining portion of said second-harmonic radiation from said second optically nonlinear crystal back to fundamental radiation.

2. The laser of claim 1, wherein said converted-frequency radiation is third-harmonic radiation generated by mixing said portion of said second-harmonic radiation with a portion of said fundamental radiation.

3. The laser of claim 2, wherein said third-harmonic radiation is delivered from said resonator as output radiation.

4. The laser of claim 2, further including a fourth optically nonlinear crystal located in said ring resonator between said second and third optically nonlinear crystals, said fourth optically nonlinear crystal arranged to mix said third-harmonic radiation with said fundamental radiation thereby providing fourth-harmonic radiation.

5. The laser of claim 2, wherein said fourth-harmonic radiation is delivered from said ring resonator as output radiation.

6. The laser of claim 2, wherein said back conversation of second-harmonic radiation is optimized when there is a particular phase relationship between said fundamental and second-harmonic radiations on entering said third optically nonlinear crystal, and wherein the laser further includes an optical arrangement for causing an optical path difference between said fundamental and third-harmonic radiations before the radiations enter the crystal, thereby causing the phase relationship between said fundamental and second-harmonic radiations entering said third optically nonlinear crystal to vary periodically with frequency of said fundamental radiation, said periodic variation being such that there is at least one possible fundamental radiation frequency of said laser resonator for which said particular phase relationship exists at said third nonlinear crystal.

7. The laser of claim 6, wherein said resonator has a mode-spacing, said gain-element has a gain bandwidth, and said periodically varying phase relationship has a period less than said gain bandwidth and greater than said mode spacing.

8. The laser of claim 7, wherein said fundamental radiation has a frequency of about 217 THz, said mode spacing is about 300 MHz, said gain bandwidth is about 30 GHz and said phase relationship variation period is about 3 GHz.

9. The laser of claim 6, wherein said path difference between said fundamental and second-harmonic radiations is adjustable.

10. The laser of claim 6, wherein second optically nonlinear crystal is located between first and second pairs of pairs of spaced apart mirrors, each pair of mirrors including a first mirror highly reflective for said fundamental radiation and highly transmissive for said second-harmonic radiation, and wherein fundamental and second-harmonic radiation generated by said first optically nonlinear crystal follows a first common path to said first one of said first pair of mirrors whereat fundamental radiation is reflected along a first

independent path and said second-harmonic radiation is transmitted to said second one of said first pair of mirrors whereat said second-harmonic radiation is reflected along a second independent path through said first one of said first pair of mirrors, said first and second ones of said first pair of mirrors being spaced and aligned such that said first and second independent paths converge at an entrance face of said second optically nonlinear crystal, and wherein said second optically nonlinear crystal is configured and aligned with respect to said first and second independent paths such that said fundamental and second-harmonic radiations travel along a second common path in said second optically nonlinear crystal and leave said second optically nonlinear crystal at an exit face thereof along respectively third and fourth independent paths diverging one from the other.

11. The laser of claim 10, wherein said fundamental and second-harmonic radiations on said third and fourth independent paths are respectively reflected by and transmitted by said first mirror of said second pair of mirrors, said transmitted second-harmonic radiation being reflected by said second mirror of said second pair of mirrors and re-transmitted through said second mirror, said first and second ones of said second pair of mirrors being spaced and aligned such that said reflected fundamental radiation and said transmitted, reflected and re-transmitted second-harmonic radiation follow a third common path to said third optically nonlinear crystal.

12. The laser of claim 11, wherein spacing between mirrors of one of said first and second pairs of mirrors is variable for adjusting said phase relationship of said fundamental and first harmonic radiations at said third optically nonlinear crystal.

13. The laser claim 1, wherein said gain-element is a Nd:YVO4 gain-element and said fundamental radiation has a wavelength of 1064 nanometers.

14. The laser of claim 1, wherein said gain-element is a semiconductor multilayer gain-structure and said fundamental radiation has a wavelength of 976 nanometers.

15. The laser of claim 1, wherein said first and third optically nonlinear crystals are LBO crystals and said second optically nonlinear crystal is a BBO crystal.

16. The laser of claim 1, wherein said first and third optically nonlinear crystals are LBO crystals and said second optically nonlinear crystal is a CLBO crystal.

17. The laser of claim 1, wherein said resonator is formed from a plurality of optical components and said optical components are spaced-apart and configured such that circulating fundamental radiation is focused to a reduced diameter at first, second and third beam waist positions, and wherein said first, second, and third, optically nonlinear crystals are located in said beam at respectively said first, second, and third waist positions.

18. The laser of claim 1, wherein said converted-frequency radiation has a non-integer relationship with said second harmonic radiation and generated by an optical parametric interaction process in said second optically nonlinear crystal.

19. The laser of claim 18, wherein said second optically nonlinear crystal is collocated in a second resonator arranged such that said converted-frequency radiation circulates therein.

20. The laser of claim 19, wherein said second resonator is a standing-wave resonator.

21. The laser of claim 20, wherein said traveling-wave resonator and said second resonator are partially coaxial and said second optically nonlinear crystal is located in said coaxial part of said resonators.

22. The laser of claim 19, wherein said converted-frequency radiation is delivered from said second resonator as output radiation.

23. A laser, comprising:

a traveling wave ring laser resonator;

first, second, and third optically nonlinear crystals located in said ring resonator;

said ring resonator including at least one gain-element generating fundamental radiation in said ring resonator, said fundamental radiation circulating through said first second and third optically nonlinear crystals in the sequence listed;

said first optically nonlinear crystal arranged to convert a portion of said fundamental radiation to second-harmonic radiation;

said second optically nonlinear crystal arranged to convert portions of said fundamental and second-harmonic radiations from said first optically nonlinear crystal into third-harmonic radiation; and

wherein said third optically nonlinear crystal is arranged to convert at least a portion of a remaining portion of said second-harmonic radiation from said second optically nonlinear crystal back to fundamental radiation; and

wherein said laser resonator is formed by a plurality of optical components into first and second superposed planes, with said optically nonlinear crystals located in said resonator in said first plane thereof and said at least one gain-element and any other gain-elements being located in said second plane thereof.

24. The laser of claim 23, wherein said resonator includes two gain-elements said plurality of optical components includes first and second prisms each thereof including two spaced-apart total internal reflecting surfaces, and first, second, third, and fourth mirrors, wherein said first and fourth mirrors are in said second plane, said second and third mirrors are in said first plane, said first and second reflecting surfaces of said first prism are in said second and first planes respectively, and said first and second reflecting surfaces of said second prism are in said first and second planes respectively, and wherein fundamental radiation generated by said gain elements is reflected from said first mirror to said first prism, sequentially reflected from said first and second surfaces of said first prism, transmitted through said first optically nonlinear crystal to said second mirror, reflected by said second mirror through said second optically nonlinear crystal to said third mirror, reflected by said

third mirror to said second prism, sequentially reflected from said first and second surfaces of said second prism, and reflected by said fourth mirror through said gain-elements.

25. The laser of claim 24, further including a fifth mirror spaced apart from said second mirror and a sixth mirror spaced apart from said third mirror, said second and third mirrors being highly reflective for said fundamental radiation and highly transmissive for said second-harmonic radiation, and wherein fundamental and second-harmonic radiation generated by said first optically nonlinear crystal follows a first common path to said second mirror whereat fundamental radiation is reflected along a first independent path and said second-harmonic radiation is transmitted to said fifth mirror whereat said second-harmonic radiation is reflected along a second independent path through said second mirror, said second and fifth mirrors being spaced and aligned such that said first and second independent paths converge at an entrance face of said second optically nonlinear crystal, and wherein said second optically nonlinear crystal is configured and aligned with respect to said first and second independent paths such that said fundamental and second-harmonic radiations travel along a second common path in said second optically nonlinear crystal and leave said second optically nonlinear crystal at an exit face thereof along respectively third and fourth independent paths diverging one from the other.

26. The laser of claim 25, wherein said fundamental and second-harmonic radiations on said third and fourth independent paths are respectively reflected by and transmitted by said third mirror, said transmitted second-harmonic radiation being reflected by said sixth mirror and re-transmitted through said third mirror, said third and sixth mirrors being spaced and aligned such that said reflected fundamental radiation and said transmitted, reflected and re-transmitted second-harmonic radiation follow a third common path to said third optically nonlinear crystal.

27. The laser of claim 26, wherein spacing between said third and sixth mirrors is variable for adjusting said phase relationship of said fundamental and first harmonic radiations at said third optically nonlinear crystal.

28. The laser of claim 26, wherein said back conversation of second-harmonic radiation is optimized when there is a particular phase relationship between said fundamental and second-harmonic radiations on entering said third optically nonlinear crystal, and wherein the spacing between said second and fifth and said third and sixth mirrors creates an optical path difference between said fundamental and third-harmonic radiations before the radiations enter said third optically nonlinear crystal thereby causing the phase relationship between said fundamental and second-harmonic radiations entering said third optically nonlinear crystal to vary periodically with frequency of said fundamental radiation, said periodic variation being such that there is at least one possible fundamental radiation frequency of said laser resonator for which said particular phase relationship exists at said third nonlinear crystal.

29. A method of generating third-harmonic radiation in a ring laser resonator, the ring laser resonator including one or more gain-elements generating fundamental laser radiation therein, the method comprising the steps of:

(a) providing first, second, and third optically nonlinear crystal located in the resonator;

(b) configuring the laser resonator such the laser radiation circulates in one direction only therein through said first, second, and third optically nonlinear crystals in the sequence listed;

(c) converting a portion of the fundamental radiation to second-harmonic radiation in said first optically nonlinear crystal;

(d) converting a portion of unconverted fundamental radiation and a portion of the second-harmonic radiation from step (c) to third-harmonic radiation in the second optically nonlinear crystal; and

(e) converting unconverted second-harmonic radiation from step (d) to fundamental radiation.

30. The method of claim 29, wherein said conversation of second-harmonic radiation in step (e) is optimized when there is a particular phase relationship between said fundamental and second-harmonic radiations on entering said third optically nonlinear

crystal, and wherein the method further includes the step of (f) creating an optical path difference between said fundamental and third-harmonic radiations before the radiations enter said third optically nonlinear crystal, thereby causing the phase relationship between said fundamental and second-harmonic radiations entering said third optically nonlinear crystal to vary periodically with frequency of said fundamental radiation, said path difference being sufficiently great that said periodic variation is such that there is at least one possible fundamental radiation frequency of said laser resonator for which said particular phase relationship exists at said third nonlinear crystal.

31. A method of generating third harmonic radiation in a traveling wave ring laser resonator having a gain medium therein generating fundamental radiation comprising the steps of:

converting the frequency of the fundamental radiation into a second harmonic thereof;

converting a combination of the fundamental and second harmonic radiation into a third harmonic thereof; and

down converting a portion of the unconverted second harmonic radiation into fundamental radiation, said down converted fundamental radiation being recirculated and used to create additional second and third harmonic radiation.